Damping of Collective Motion in a Rotating Nucleus – a Linear Response Approach ◇

F.A. Ivanyuk [a,b] and S. Yamaji [b]
[a] Institute for Nuclear Research of the Ukrainian Academy, 03028 Kiev-28, Ukraine
[b] RIKEN, 2-1 Hirosawa, Wako-Shi, Saitama 351-0106, Japan

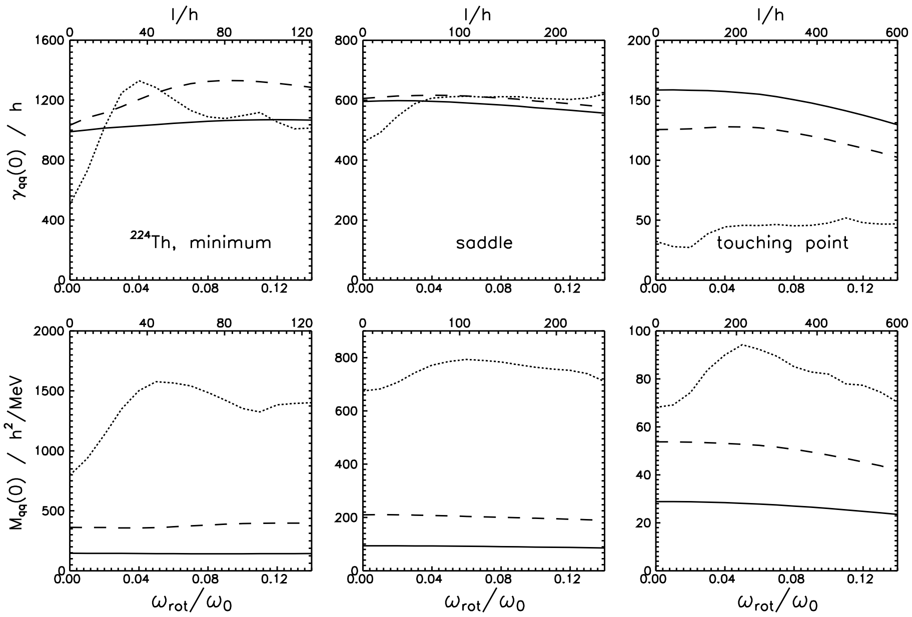

Fig. 1: The friction $\gamma_{qq}(0)$ and inertia $M_{qq}(0)$ for the elongation mode as function of the average value of rotational moment I (upper x-axes) or rotational frequency ω_{rot} (lower x-axes). Dotted, dashed and solid curves correspond to temperatures $T = 1, 2$ and 3 MeV. The computations are done for few deformation of nucleus ^{224}Th which correspond to the minimum of potential energy, saddle and two touching spheres

First studies of the influence of rotations on damping of collective motion had been published in [1]. There this effect was seen to be quite large, but because of technical difficulties no further examination of this important feature had been performed. Recently this problem has been taken up again within the linear response approach based on the two center shell model [3], see also [2]. The computer code of this model has been generalized to rotating systems and the influence of overall rotations on friction γ and inertia M has been examined. To simplify matters the internal excitation was restricted to values above $T = 1$ MeV such that pairing could be neglected.

Unexpectedly, friction and inertia were found to be sensitive to such finer effects as the violation of rotational symmetry, leading to spurious contributions to γ and M. The latter were seen to be (at least) as large as the correct values. To the best of our knowledge so far this circumstance was unclear. To cure this problem and to get reliable values for γ and M we used the Lipkin-Nogami method to restore the broken symmetry. As a result we obtained friction and mass parameters which exhibit a rather reasonable dependence on the rotational frequency ω_{rot}. For excitations above $T = 2$ MeV, where the microscopic shell effects have disappeared, both γ and M are rather insensitive to the rotation, and in a sense behave like macroscopic quantities. For 1Mev $\leq T \leq$ 2MeV at first an increase of γ and M with growing ω_{rot} is seen, as can be found from fig.1. Above about $\omega_{rot} \simeq 0.05\omega_0$ this dependence is modified. Such effects might be caused by the change of shell structure due to the re-arrangement of single-particle states by rotation.

An even stronger dependence of γ and M on ω_{rot} should be expected for $T \leq 1$ MeV when both shell and pairing effects are present. As it was shown in [4,5] pairing effects change considerably the collective transport at low excitations. Likewise, the destruction of pairing by rotations may have substantial effects on the transport coefficients. Such details could be very important for accurate descriptions, for example, of the final stage of fusion reactions in general, and the formation of super heavy elements, in particular, which takes place at low excitation energies.

References

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